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Environmental Visualization for Sonar Tactical Decision Aids

William Wright
Visual Insights Inc.
555 Richmond St. W., Suite 1108
Toronto, ON M5V 3B1, Canada
bill.wright@visualinsights.com

The coverage and timeliness of environmental data is improving significantly. New analytical acoustical models offer increased resolution and greater accuracy. PC computing platforms are orders of magnitude faster. There is a need to turn a moderately slow environment assessment into a rapid environment assessment.

Given near-complete environmental data and faster more accurate models, DERA recently posed the question of how can these capabilities be harnessed to improve the performance of ASW sonar operations and tactical decision making. How would this environmental data be displayed? Visualization is one tool that can be beneficial in presenting and exploiting the environmental picture.

Visualization is a valuable tool anywhere there are large amounts of data, and/or multi-dimensional data, and/or the need for context and focus, and most importantly, where ever people need to be in the loop.

Interactive 2D and 3D visualizations allow people to see more data, more quickly with more comprehension. Situation awareness, and decision-making processes can benefit from combining data, graphics and interaction. Understanding is increased, tasks are completed more quickly, critical data and analytical resources are fully used, confidence is increased and decisions are improved.

Visualization is a tool for enhancing human performance especially when decisions are not black and white. "ASW is a thinking man's war" with many changing conditions and situations. Visualization can be an external cognitive aid. It can help provide greater understanding of sonar conditions and sensor effectiveness. The need is great. *"Submarines live in the underwater environment all the time while surface ships are there only a little time."* Surface ships need greater insight into the underwater environment, how it affects their performance and any opportunities for improving their performance. In ASW operations, the environment has significant tactical consequences. Environmental factors are influential in many command decisions. Command wants to know, "Where am I going to acquire the target? And from how far away?"

During the course of a project sponsored by DERA, a number of design concepts were developed that show how interactive 2-D and 3-D linked visualizations can address some of these ASW requirements.

A user interface framework was developed with several display elements, including: environmental view, acoustic analyzer, thumbnails view, and a key plan view. This framework allows acoustic model data to be viewed in context with the related environmental factors, for the purpose of making timely, informed tactical decisions.

These display elements are linked. Changes in one view can affect, and be seen, in the other views. For example, changing slice depth in one view causes an update in the other views too. Tightly coupled interactions enhance user comprehension of related complex factors. "What if" analysis is supported via tightly coupled interactions. For example, a user can change the FOM setting and instantly see the impact on ranges in all views.

An isosurface is used to show the acoustic volume in the acoustic analyzer view. The isosurface works by taking a discrete value from the user and creating a "shell" composed by connecting all of the instances of that value in a volume. An isosurface traces the path or paths of a single threshold value in three dimensional data space and displays them using one or more surfaces. This is used to create a shell indicating, for example, the placement of a specific confidence volume within a larger volume of seawater, as well as other volumetric propagation loss properties.

The Thumbnails component is a comparison tool designed to visualize, store and recall the relation between acoustic property surfaces at different parameter settings. The shape and size of the surface will be different based on the parameter settings; and this component provides a graphical representation of the surfaces to allow for a quick visual comparison between them.

The designs discussed here were targeted for implementation using the highest end Windows / Intel / graphics accelerator platform possible. These capabilities can be implemented in Java, in order to provide platform flexibility, and would require using a commercial off the shelf toolkit.

The visualization design goals included maximizing readability, useability, with a clear insightful display that uses natural visual paradigms.

The visualization supports the visual fusion of different data in the same display.

These design concepts are presented in this NATO forum for review, and with the intention of generating discussion and suggestions for improvement.

Paper presented at the RTO IST Workshop on "Multimedia Visualization of Massive Military Datasets", held in Quebec, Canada, 6-9 June 2000, and published in RTO-MP-050.

Discussion – Paper 8

The multiple views are an asset. The display shows multiple levels of command and the reasons for decisions.

Suggestions for improvement:
- Currently only one sensor is used, could multiple sensors be deployed?
- Ability to toggle aspects on and off and show transparency
- Show how a sound ray might be bent in the sea

If there is a sub in location X, how do you decide where to place the sensors?
- Not readily covered

How do the ASW people feel about this?
- The users have been involved in the development cycle through interviews, display updates, and reviews.

Validation and quantification processes are underway.